Optimizing a High-volume Pump and Treat System at Air Force Plant 44

Jim Hatton
Earth Tech, Inc.
5575 DTC Parkway
Englewood, Colorado 80111
Phone: 303-804-2314, Email: jim.hatton@earthtech.com

The Air Force Center for Environmental Excellence (AFCEE) and the Aeronautical System Center (ASC) have optimized operation of a large-scale groundwater remediation system at Air Force Plan 44 (AFP 44). Implementation of the recommendations is in progress. The RPO at AFP 44 has helped the facility better manage risks and should significantly reduce long-term operating costs.

Background

AFP 44 was constructed in 1951 near the Tucson International Airport to manufacture Falcon air-to-air missiles. Past disposal practices included industrial wastewater treatment, unlined surface impoundments; and land disposal of spent solvents.

In 1981, the United States Environmental Protection Agency (USEPA) and the Arizona Department of Health Services (ADHS) found trichloroethene (TCE) and other contaminants in the regional aquifer. The Tucson International Airport Authority (TIAA) Superfund site was added to the National Priorities List in 1983. In response, the United States Air Force (USAF) initiated groundwater investigations that determined these contaminants also existed under AFP 44. A Record of Decision (ROD) was signed in 1986 (EPA 1986) and a groundwater reclamation system was activated in 1987. Soil remediation, by a variety of methods, is on going. The AFP 44 portion of the TIAA Superfund site is the southernmost (up gradient) portion of the regional aquifer plume and related areas. Releases from other TIAA facilities appear to have contributed to the regional aquifer plume down gradient from AFP 44 (Earth Tech 2001).

Earth Tech, Inc. (Earth Tech) assisted AFCEE in conducting the RPO at AFP 44 beginning in 2000. Earth Tech provided engineering and hydrogeologic support to a multidisciplinary RPO team assembled by AFCEE to conduct Phase I activities and then conducted Phase II activities on AFCEE's behalf (Earth Tech 2000a).

Methods

RPO is a systematic approach for evaluating and improving the effectiveness of site remediation. The Remedial Process Optimization approach is described in the Air Force Remedial Process Optimization Handbook (AFCEE 2001).

For AFP 44, the RPO team conducted the RPO Scoping Visit (RSV) in September 2000 (Earth Tech 2000b). The RSV presented recommendations that could be implemented to improve the cost-effectiveness of the facility. Some, such as reducing the monitoring for closure of soil vapor extraction/dual phase extraction (SVE/DPE) sites, were implemented immediately. Other recommendations required study and support to implement. Based on the findings of the RSV and the need for support prior to implementation, three tasks were selected by the facility and the USAF for Phase II optimization:

- Vapor-Phase Granular Activated Carbon (GAC) Use
- Groundwater Treatment Plant (GWTP) Operation
- Groundwater Flow

The Phase II tasks are described below (Earth Tech 2001).

GAC optimization consisted of identifying criteria governing the discharge of volatile organic compounds (VOCs) at AFP 44, modeling concentrations currently treated by a single GAC unit to receptors, and comparing those concentrations to the criteria. The criteria selected were inhalation toxicity, the 8-hour Occupational Safety and Health Administration permissible exposure limit, and the American Conference of Governmental Industrial

Hygienists threshold limit value. If modeled concentrations met criteria at potential receptors, then the discharge potentially did not require further treatment. The receptors considered were an on-site worker and a resident at the downwind property boundary.

Groundwater flow optimization consisted of converting an existing two-dimensional groundwater model (Errol L. Montgomery 2000) used to simulate groundwater flow and contaminant transport at AFP 44 to MODFLOW. The MODFLOW model was then used to evaluate various pumping and injection scenarios. The model assumed that the several source areas thought present at AFP 44 continued to contribute to the groundwater plume as previously defined.

Scenarios were evaluated to first assess the performance of the model and then to compare different operating configurations. A "no action" scenario was run first to determine if the model would develop a groundwater plume similar to the pre-remediation plume. The current configuration was modeled to provide a baseline of performance and as a configuration thought to maximize contaminant mass capture.

The pumping system was then modeled to contain the groundwater plume, or prevent contaminants from leaving AFP 44. For these models, the number of wells pumped and flow rates were varied for different schemes to determine a configuration that provided adequate capture while minimizing flow.

GWTP optimization consisted of determining if modifications to the processes used at the GWTP would result in more efficient groundwater treatment. The GWTP treats 2,200 gallons per minute (gpm) of groundwater using two of the three treatment trains at the GWTP, each train consisting of two stripping towers arranged in pairs in parallel.

Optimization began with inspecting the GWTP to assess operation and maintenance procedures, to verify flow pathways, and to collect samples. Using the concentrations determine during Phase II and historic flow rates, a mass balance was constructed around the treatment processes. The mass balance allowed the evaluation of treatment efficiencies and allowed modeling of the air stripping process.

The stripping towers were modeled individually and in pairs, using representative flow rates and contaminant concentrations. Costs of the current operation were obtained from Raytheon. Costs for potential improvements were obtained from venders or through cost-estimating literature.

Results of Phase II Optimization

The following were reported in the Phase II report.

GAC optimization found that DCE concentrations (thought to be a minor constituent) exceeded standards during occasional breakthrough at two of the three SVE sites. TCE concentrations did not exceed standards at any site. Neither TCE nor DCE from the GWTP stripping towers without GAC treatment, exceeded standards.

For the SVE sites, two approaches were evaluated to remedy the exceedences: either raising the height of discharge using an exhaust stack, or adding a second GAC unit operated in a lead-lag arrangement. If the plant chose to raise the height of the stacks, the required stack heights were in the range of 20 to 40 feet. Lead-lag GAC management would allow GAC change out prior to breakthrough and prevent discharge.

Groundwater flow optimization indicated the current configuration of the pumping system could not remediate the site in 30 years. If complete source removal was obtained, the current system appeared capable of remediating the site in slightly more than 30 years. Modeling identified a configuration, consisting of pumping at each source area and at the down-gradient property boundary, that contained the plume on-site but pumped at less than half the current pumping rate (970 gpm versus 2,200 gpm). This configuration removed approximately 96 percent of the mass that that the current configuration removed over 30 years while pumping approximately 45 percent of the water.

Groundwater treatment plant optimization indicated that if the flow rate were reduced to 1,750 gpm or less, the GWTP could operate with one treatment train, resulting in a significant reduction in cost. If the mass loading to the GWTP could be also be reduced, then only one stripping tower would be required to treat the groundwater, resulting in additional cost savings.

Recommendations and Discussion

The Phase II RPO recommended that GAC treatment should cease at the GWTP, but GAC treatment should be improved or supplemented for SVE and DPE systems. It also recommended that the plant cut the pumping rate to approximately 1,000 gpm.

Currently, AFP 44 has installed discharge stacks on all of the SVE and DPE systems as recommended. However, because of recent changes in published toxicity values for TCE and DCE (EPA 2003), AFP 44 is re-evaluating the risk from off-gases. Based on the results of this evaluation, further treatment may be required for TCE. Implementing the RPO recommendations has allowed the facility to better manage risk.

In 2001, a near-by facility within the TIAA Superfund Site proposed extraction and air stripping of TCE – contaminated groundwater without off-gas treatment to the TIAA Remediation Advisory Board (RAB). The proposal was not well received and the regulatory agency decided to require off-gas treatment in response to citizen concerns. Because of this regulatory decision, the plant has chosen not to propose removing off-gas treatment from the GWTP.

During 2001, as the Phase II RPO neared completion, AFP 44 analyzed groundwater samples for 1,4-dioxane, a solvent stabilizer that a significant additive in 1,1,1-trichloroethane (TCA) and is notoriously recalcitrant (Mohr 2001). Results indicated 1,4-dioxane was present in the GWTP influent and effluent in excess of the proposed Arizona standard. The compound was present in areas where TCA had been previously detected and in areas where groundwater had been reinjected. The plant is currently modeling capture of 1,4-dioxane and TCE to optimize pumping rates, with the goal of reducing the pumping rate to near 1,000 gpm as recommended in the RPO. The plant is also planning a Feasibility Study of alternatives for 1,4-dioxane treatmen.

The RPO at AFP 44 has assisted the facility in better managing costs and risk. Some of the recommendations, including a Phase II recommendation (adding stacks to DPE systems), have been implemented in full. One of the Phase II recommendations (ending GAC treatment at the GWTP) will not be implemented because of community concerns. The most significant Phase II recommendation (reducing the groundwater pumping rate) has been accepted in principle and is likely to be implemented later, once the impact of newly discovered contaminants is evaluated. The RPO at AFP 44 has helped the facility more effectively manage risk, and in the long term, should significantly reduce operating cost. In addition, the RPO has provided AFP 44 with a working groundwater model that will facilitate long-term management of the site.

References

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